CLAIMS

1. A method of performing incremental redundancy (IR) transmission in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

processing a first data packet to obtain a first plurality of symbol blocks;

processing a second data packet to obtain a second plurality of symbol blocks;

transmitting the first plurality of symbol blocks, one symbol block at a time, on a first parallel channel to a receiver;

transmitting the second plurality of symbol blocks, one symbol block at a time, on a second parallel channel to the receiver;

terminating transmission of the first plurality of symbol blocks early if the first data packet is recovered by the receiver with fewer than all of the first plurality of symbol blocks; and

terminating transmission of the second plurality of symbol blocks early if the second data packet is recovered by the receiver with fewer than all of the second plurality of symbol blocks.

2. The method of claim 1, further comprising:

processing a third data packet to obtain a third plurality of symbol blocks;

transmitting the third plurality of symbol blocks, one symbol block at a time, on a third parallel channel to the receiver; and

terminating transmission of the third plurality of symbol blocks early if the third data packet is recovered by the receiver with fewer than all of the third plurality of symbol blocks.

3. The method of claim 1, further comprising:

receiving an indication that the first data packet has been recovered;

estimating throughput for the first and second parallel channels with no transmission on the first parallel channel until the second data packet is recovered;

estimating throughput for the first and second parallel channels with transmission of a new data packet on the first parallel channel after the first data packet; and

transmitting the new data packet on the first parallel channel if the throughput with transmission on the first parallel channel is greater than the throughput with no transmission on the first parallel channel.

4. The method of claim 1, further comprising:

receiving an indication that the first data packet has been recovered; and

transmitting no data packets on the first parallel channel until the second data packet is recovered.

5. The method of claim 4, wherein symbol blocks for the second data packet are transmitted at full transmit power after terminating transmission of the first plurality of symbol blocks for the first data packet.

6. The method of claim 1, further comprising:

receiving an indication that the first data packet has been recovered;

processing a third data packet to obtain a set of at least one symbol block for the third data packet; and

transmitting the set of at least one symbol block, one symbol block at a time, on the first parallel channel.

7. The method of claim 6, wherein the third data packet is expected to be recovered by the receiver at or before a time instant when the second data packet is expected to be recovered.

8. The method of claim 6, wherein the third data packet is expected to be recovered by the receiver after a time instant when the second data packet is expected to be recovered.

9. The method of claim 8, further comprising:

terminating transmission of the second plurality of symbol blocks after a predetermined number of symbol blocks.

10. The method of claim 6, further comprising:

increasing transmit power for the third packet and reducing transmit power for the second packet at or after a time instant when the second data packet is expected to be recovered.

11. The method of claim 1, further comprising:

receiving an indication that the first data packet has been recovered;

processing a third data packet to obtain a third plurality of symbol blocks for the third data packet;

transmitting the third plurality of symbol blocks, one symbol block at a time, on the first parallel channel after the first data packet;

receiving an indication that the second data packet has been recovered;

processing a fourth data packet to obtain a fourth plurality of symbol blocks; and

transmitting the fourth plurality of symbol blocks, one symbol block at a time, on the second parallel channel after the second data packet.

12. The method of claim 1, further comprising:

receiving a first rate for the first parallel channel and a second rate for the second parallel channel, and wherein the first and second data packets are processed in accordance with the first and second rates, respectively.

13. The method of claim 12, wherein the processing the first data packet includes

encoding the first data packet in accordance with a coding scheme indicated by the first rate to obtain a coded packet,

partitioning the coded packet into a plurality of coded subpackets, and

modulating the plurality of coded subpackets in accordance with a modulation scheme indicated by the first rate to obtain the first plurality of symbol blocks.

14. The method of claim 1, wherein one symbol block in the first plurality of symbol blocks includes all systematic bits for the first data packet and is transmitted first for the first data packet.

15. The method of claim 1, further comprising:

receiving at least one symbol block, selected from among the first and second pluralities of symbol blocks, for transmission in one time slot on the first and second parallel channels; and

spatially processing the at least one symbol block with a transmit basis matrix to obtain a plurality of transmit symbol sequences for a plurality of transmit antennas.

16. The method of claim 1, wherein the first and second parallel channels are formed so as to achieve similar signal-to-noise-and-interference ratios (SINRs) after linear detection at the receiver.

17. The method of claim 1, wherein the first and second parallel channels correspond to first and second transmit antennas at a transmitter in the MIMO system.

18. The method of claim 1, wherein the first and second parallel channels correspond to first and second spatial channels in the MIMO system.

19. The method of claim 1, wherein the MIMO system implements orthogonal frequency division multiplexing (OFDM), and wherein each of the first and second parallel channels is formed with a plurality of subbands and a plurality of transmit antennas.

20. The method of claim 19, wherein a plurality of parallel channels are formed by diagonally cycling through the plurality of subbands of the plurality of transmit antennas, the plurality of parallel channels including the first and second parallel channel.

21. The method of claim 1, wherein the MIMO system implements orthogonal frequency division multiple access (OFDMA), and wherein each packet is transmitted on a set of subbands available for data transmission.

22. The method of claim 1, wherein a plurality of data packets are processed and transmitted simultaneously on a plurality of parallel channels, wherein transmission of symbol blocks for each data packet is terminated early if the data packet is recovered

by the receiver with fewer than all symbol blocks generated for the data packet, and wherein total transmit power is distributed among data packets not yet terminated.

23. A transmitter operative to perform incremental redundancy (IR) transmission in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

a data processor operative to process a first data packet to obtain a first plurality of symbol blocks and process a second data packet to obtain a second plurality of symbol blocks; and

a controller operative to

initiate transmission of the first plurality of symbol blocks, one symbol block at a time, on a first parallel channel to a receiver,

initiate transmission of the second plurality of symbol blocks, one symbol block at a time, on a second parallel channel to the receiver,

terminate transmission of the first plurality of symbol blocks early if the first data packet is recovered by the receiver with fewer than all of the first plurality of symbol blocks, and

terminate transmission of the second plurality of symbol blocks early if the second data packet is recovered by the receiver with fewer than all of the second plurality of symbol blocks.

24. The transmitter of claim 23, wherein the controller is further operative to

receive an indication that the first data packet has been recovered;

estimate throughput for the first and second parallel channels with no transmission on the first parallel channel until the second data packet is recovered;

estimate throughput for the first and second parallel channels with transmission of a new data packet on the first parallel channel after the first data packet; and

initiate transmission of the new data packet on the first parallel channel if the throughput with transmission on the first parallel channel is greater than the throughput with no transmission on the first parallel channel.

25. The transmitter of claim 23, wherein the data processor is further operative to process a third data packet to obtain a third plurality of symbol blocks, and wherein the controller is further operative to initiate transmission of the third plurality of symbol blocks, one symbol block at a time, on the first parallel channel upon receiving an indication that the first data packet has been recovered.

26. The transmitter of claim 23, wherein the data processor is operative to

encode the first data packet in accordance with a coding scheme indicated by a rate selected for the first parallel channel to obtain a coded packet,

partition the coded packet into a plurality of coded subpackets, and

modulate the plurality of coded subpackets in accordance with a modulation scheme indicated by the rate to obtain the first plurality of symbol blocks.

27. The transmitter of claim 23, further comprising:

a spatial processor operative to receive at least one symbol block, selected from among the first and second pluralities of symbol blocks, for transmission in one time slot on the first and second parallel channels and to spatially process the at least one symbol block with a transmit basis matrix to obtain a plurality of transmit symbol sequences for a plurality of transmit antennas.

28. An apparatus operative to perform incremental redundancy (IR) transmission in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

means for processing a first data packet to obtain a first plurality of symbol blocks;

means for processing a second data packet to obtain a second plurality of symbol blocks;

means for transmitting the first plurality of symbol blocks, one symbol block at a time, on a first parallel channel to a receiver;

means for transmitting the second plurality of symbol blocks, one symbol block at a time, on a second parallel channel to the receiver;

means for terminating transmission of the first plurality of symbol blocks early if the first data packet is recovered by the receiver with fewer than all of the first plurality of symbol blocks; and

means for terminating transmission of the second plurality of symbol blocks early if the second data packet is recovered by the receiver with fewer than all of the second plurality of symbol blocks.

29. The apparatus of claim 28, further comprising:

means for processing a third data packet to obtain a set of at least one symbol block for the third data packet; and

means for transmitting the set of at least one symbol block, one symbol block at a time, on the first parallel channel upon receiving an indication that the first data packet has been recovered.

30. The apparatus of claim 28, further comprising:

means for processing a third data packet to obtain a third plurality of symbol blocks for the third data packet;

means for transmitting the third plurality of symbol blocks, one symbol block at a time, on the first parallel channel upon receiving an indication that the first data packet has been recovered;

means for processing a fourth data packet to obtain a fourth plurality of symbol blocks; and

means for transmitting the fourth plurality of symbol blocks, one symbol block at a time, on the second parallel channel upon receiving an indication that the second data packet has been recovered.

31. A method of receiving an incremental redundancy (IR) transmission on first and second parallel channels in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

receiving a symbol block for a first data packet transmitted via the first parallel channel, wherein a first plurality of symbol blocks are generated for the first data packet and transmitted one symbol block at a time on the first parallel channel;

decoding all symbol blocks received for the first data packet to obtain a first decoded packet;

determining whether the first data packet is recovered based on the first decoded packet;

terminating the receiving, decoding, and determining for the first data packet if the first data packet is recovered or if all of the first plurality of symbol blocks have been received;

receiving a symbol block for a second data packet transmitted via the second parallel channel, wherein a second plurality of symbol blocks are generated for the second data packet and transmitted one symbol block at a time on the second parallel channel;

decoding all symbol blocks received for the second data packet to obtain a second decoded packet;

determining whether the second data packet is recovered based on the second decoded packet; and

terminating the receiving, decoding, and determining for the second data packet if the second decoded packet is recovered or if all of the second plurality of symbol blocks have been received.

32. The method of claim 31, wherein decoding, determining, and terminating for the first data packet are performed whenever a symbol block is received for the first

data packet, and wherein the decoding, determining, and terminating for the second data packet are performed whenever a symbol block is received for the second data packet.

33. The method of claim 31, further comprising:

performing detection on a plurality of received symbol sequences for a plurality of receive antennas to obtain the symbol block for the first data packet and the symbol block for the second data packet.

34. The method of claim 33, wherein the detection is performed based on a minimum mean square error (MMSE) detector, a maximal ratio combining (MRC) detector, or a linear zero-forcing (ZF) detector.

35. The method of claim 31, wherein the receiving, decoding, determining, and terminating for the first data packet are performed independently of the receiving, decoding, determining, and terminating for the second data packet.

36. The method of claim 31, wherein the first data packet is designated to be recovered before the second data packet, and wherein the decoding, determining, and terminating for the second data packet are not performed until the first data packet is recovered.

37. The method of claim 31, further comprising:

if the first data packet is recovered,

estimating interference due to the first data packet on the second data packet, and

canceling the interference due to the first data packet from symbol blocks received for the second data packet, and wherein all symbol blocks received for the second data packet, with the interference from the first data packet canceled, are decoded to obtain the second decoded packet.

38. The method of claim 31, wherein the first data packet is recovered before the second data packet and a new data packet is not transmitted on the first parallel channel until the second data packet is recovered.

39. The method of claim 37, further comprising:

if the first data packet is recovered,

receiving a symbol block for a third data packet transmitted via the first parallel channel, wherein a set of at least one symbol block is generated for the third data packet and transmitted one symbol block at a time on the first parallel channel after the first data packet,

decoding all symbol blocks received for the third data packet to obtain a third decoded packet,

determining whether the third data packet is recovered based on the third decoded packet, and

terminating the receiving, decoding, and determining for the third data packet if the third data packet is recovered or if all of the set of at least one symbol block has been received.

40. The method of claim 39, further comprising:

if the third data packet is recovered,

estimating interference due to the third data packet on the second data packet, and

canceling the interference due to the third data packet from the symbol blocks received for the second data packet, and wherein all symbol blocks received for the second data packet, with the interference from the first and third data packets canceled, are decoded to obtain the second decoded packet.

41. The method of claim 39, wherein the third data packet is expected to be recovered at or before a time instant when the second data packet is expected to be recovered.

42. The method of claim 39, wherein the third data packet is expected to be recovered after a time instant when the second data packet is expected to be recovered.

43. The method of claim 37, further comprising:

if the first data packet is recovered,

receiving a symbol block for a third data packet transmitted via the first parallel channel, wherein a third plurality of symbol blocks are generated for the third data packet and transmitted one symbol block at a time on the first parallel channel after the first data packet,

decoding all symbol blocks received for the third data packet to obtain a third decoded packet,

determining whether the third data packet is recovered based on the third decoded packet, and

terminating the receiving, decoding, and determining for the third data packet if the third data packet is recovered or if all of the third plurality of symbol blocks has been received; and

if the second decoded packet is recovered,

estimating interference due to the second data packet on the third data packet, and

canceling the interference due to the second data packet from the symbol blocks received for the third data packet, and wherein all symbol blocks received for the third data packet, with the interference from the second data packet canceled, are decoded to obtain the third decoded packet.

44. The method of claim 31, further comprising:

obtaining signal-to-noise-and-interference ratio (SINR) estimates for the first and second parallel channels; and

selecting a first rate for the first parallel channel and a second rate for the second parallel channel based on the SINR estimates, and wherein the first and second data packets are decoded in accordance with the first and second rates, respectively.

45. The method of claim 31, further comprising:

sending an acknowledgment (ACK) if the first data packet is recovered or a negative acknowledgment (NAK) if the first data packet is not recovered.

46. A method of receiving an incremental redundancy (IR) transmission on a plurality of parallel channels in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

obtaining a plurality of symbol blocks for a plurality of data packets transmitted on the plurality of parallel channels in a current period, one symbol block for each data packet and one data packet for each parallel channel, wherein multiples symbol blocks are generated for each data packet and transmitted one symbol block at a time on an associated parallel channel;

selecting one of the plurality of parallel channels for recovery;

decoding all symbol blocks obtained for a data packet transmitted on the selected parallel channel to obtain a decoded packet;

determining whether the data packet transmitted on the selected parallel channel is recovered based on the decoded packet;

terminating the obtaining, decoding, and determining for the data packet transmitted on the selected parallel channel, if the data packet is recovered or if all of the multiple symbol blocks have been obtained for the data packet; and

estimating and canceling interference due to the data packet transmitted on the selected parallel channel, if the data packet is recovered.

47. The method of claim 46, wherein a parallel channel with a highest likelihood of being recovered, among the plurality of parallel channels, is selected for recovery.

48. The method of claim 46, wherein a parallel channel that is last recovered furthest away in time from the current period, among the plurality of parallel channels, is selected for recovery.

49. The method of claim 46, wherein a parallel channel with a highest number of data symbol blocks in the current period, among the plurality of parallel channels, is selected for recovery.

50. The method of claim 46, wherein the selecting, decoding, determining, terminating, and estimating and canceling are performed for each of the plurality of parallel channels in the current period.

51. The method of claim 46, wherein the selecting, decoding, determining, terminating, and estimating and canceling are performed for the plurality of parallel channels, one parallel channel at a time and in a cycled order, the cycled order being defined such that one or more parallels most recently recovered are placed last and are recovered last subsequently.

52. The method of claim 46, wherein the selecting, decoding, determining, terminating, and estimating and canceling are performed for the plurality of parallel channels, one parallel channel at a time and in a predetermined order, in the current period.

53. The method of claim 52, wherein the predetermined order is selected based on likelihood of recovering the data packet on each of the plurality of parallel channels.

54. The method of claim 52, wherein the predetermined order is selected based on an order in which data packets previously transmitted on the plurality of parallel channels are recovered.

55. The method of claim 46, wherein the plurality of parallel channels have similar signal-to-noise-and-interference ratios (SINRs) after linear detection at a receiver.

56. The method of claim 46, wherein the plurality of parallel channels are formed by transmitting diagonally across a plurality of subbands of a plurality of transmit antennas.

57. A receiver operative to receive an incremental redundancy (IR) transmission on first and second parallel channels in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

a data processor operative to

receive a symbol block for a first data packet via the first parallel channel, wherein a first plurality of symbol blocks are generated for the first data packet and transmitted one symbol block at a time on the first parallel channel,

decode all symbol blocks received for the first data packet to obtain a first decoded packet,

determine whether the first data packet is recovered based on the first decoded packet,

receive a symbol block for a second data packet via the second parallel channel, wherein a second plurality of symbol blocks are generated for the second data packet and transmitted one symbol block at a time on the second parallel channel,

decode all symbol blocks received for the second data packet to obtain a second decoded packet, and

determine whether the second data packet is recovered based on the second decoded packet; and

a controller operative to

terminate processing by the data processor for the first data packet if the first data packet is recovered or if all of the first plurality of symbol blocks have been received, and

terminate processing by the data processor for the second data packet if the second decoded packet is recovered or if all of the second plurality of symbol blocks have been received.

58. The receiver of claim 57, further comprising:

a spatial processor operative to receive a plurality of symbol sequences for a plurality of receive antennas and perform detection on the plurality of received symbol sequences to obtain the symbol block for the first data packet and the symbol block for the second data packet.

59. The receiver of claim 58, wherein the spatial processor is operative to, if the first data packet is recovered, estimate interference due to the first data packet on the second data packet and cancel the interference due to the first data packet from symbol blocks received for the second data packet, and wherein the data processor is operative

to decode all symbol blocks received for the second data packet, with the interference from the first data packet canceled, to obtain the second decoded packet.

60. The receiver of claim 57, further comprising:

a channel estimator operative to obtain signal-to-noise-and-interference ratio (SINR) estimates for the first and second parallel channels; and

a rate selector operative to select a first rate for the first parallel channel and a second rate for the second parallel channel based on the SINR estimates, and

wherein the data processor is operative to decode the first and second data packets in accordance with the first and second rates, respectively.

61. An apparatus for receiving an incremental redundancy (IR) transmission on first and second parallel channels in a wireless multiple-input multiple-output (MIMO) communication system, comprising:

means for receiving a symbol block for a first data packet via the first parallel channel, wherein a first plurality of symbol blocks are generated for the first data packet and transmitted one symbol block at a time on the first parallel channel;

means for decoding all symbol blocks received for the first data packet to obtain a first decoded packet;

means for determining whether the first data packet is recovered based on the first decoded packet;

means for terminating the receiving, decoding, and determining for the first data packet if the first data packet is recovered or if all of the first plurality of symbol blocks have been received;

means for receiving a symbol block for a second data packet via the second parallel channel, wherein a second plurality of symbol blocks are generated for the second data packet and transmitted one symbol block at a time on the second parallel channel;

means for decoding all symbol blocks received for the second data packet to obtain a second decoded packet;

means for determining whether the second data packet is recovered based on the second decoded packet; and

means for terminating the receiving, decoding, and determining for the second data packet if the second decoded packet is recovered or if all of the second plurality of symbol blocks have been received.

62. The apparatus of claim 61, further comprising:

means for receiving a plurality of symbol sequences for a plurality of receive antennas; and

means for performing detection on the plurality of received symbol sequences to obtain the symbol block for the first data packet and the symbol block for the second data packet.

63. The apparatus of claim 61, further comprising:

means for estimating interference due to the first data packet on the second data packet, if the first data packet is recovered; and

means for canceling the interference due to the first data packet from symbol blocks received for the second data packet, and wherein all symbol blocks received for the second data packet, with the interference from the first data packet canceled, are decoded to obtain the second decoded packet.